

Technology Opportunity

Liquid Manipulation by Acoustic Radiation Pressure

A high intensity beam of ultrasound can create acoustic radiation pressure, or ARP. This pressure can be used to agitate liquid, displace surfaces or propel objects without physical contact or mechanical hardware, and eject or deploy droplets.

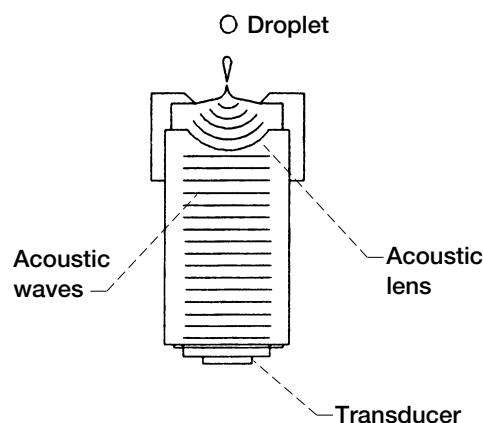
Potential Commercial Uses

- ARP agitation
 - Agitate liquids in sealed containers
 - Suspend slurries and particle for coatings and paints
 - Maintain uniformity in mixtures both before and during application
- ARP liquid manipulation (by electronically steered and focused acoustic phased arrays)
 - Position objects such as bubbles, liquids, or solid objects for medical or scientific research
 - Remove bubbles or solids from liquids, without filters
 - Reposition tissues like a detached retina in the human eye

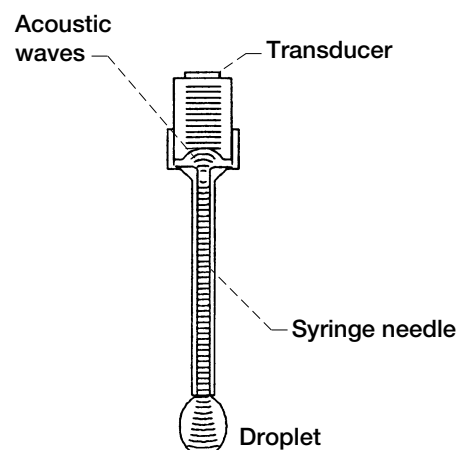
- ARP drop ejection (a nozzleless method to eject droplets of low-viscosity liquids, including high-density liquid metals and slurries)
 - Microdispensing of drugs
 - Applying maskless coatings
- ARP drop dispensing (a method that uses a syringe needle as an acoustic wave guide for high viscosity liquids)
 - Applying mask-free coatings
 - Depositing adhesives (high viscosity)
 - Depositing solder pastes

Benefits

- Nonintrusive—ARP permits us to manipulate liquids inside hermetically sealed containers. Because acoustic energy is transmitted through intervening barriers, the acoustic transducers are safely isolated from the liquid. This eliminates the need for mechanical seals and bearings that would be attacked by reactive or abrasive liquids.

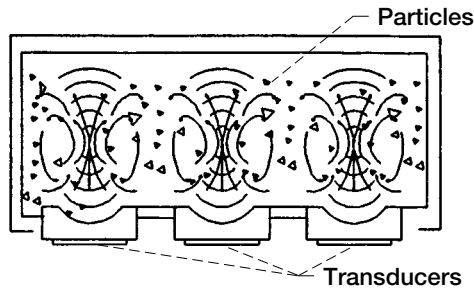


ARP (nozzleless) drop ejection.

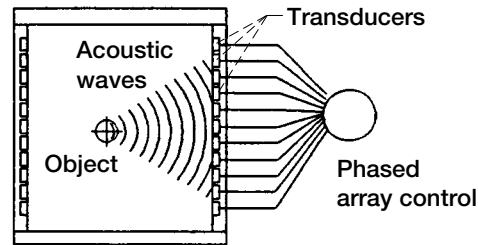


ARP (waveguide) drop dispensing.





ARP agitation.



ARP manipulation by acoustic phased array.

- Precise liquid control—Burst modulation permits precise power control. High frequency provides precise focusing and permits manipulation to microscopic levels. These techniques let the user precisely deposit small amounts of material on demand. Precise droplet placement can eliminate masking and screening steps for applying coatings. Maskless coating eliminates manufacturing steps and tooling and reduces chemicals, which makes the process inherently cleaner.
- Advanced manipulation—ARP produced by acoustic phased arrays is significantly more controllable because of computer-controlled electronic beam steering and focusing.

The Technology

Acoustic Radiation Pressure (ARP) is an effect of high-intensity ultrasound that creates direct pressure against surfaces and objects. ARP can also create liquid currents referred to as “acoustic streaming.” Precise control of these effects allows us to manipulate liquids or objects suspended in the liquid and, therefore, move them exactly where we want them. Since ARP can be transmitted through intervening barriers, it can manipulate liquid in sealed

containers. NASA is investigating the use of ARP for controlling liquids in space, including remote control agitation of liquids in experiments and propellant tanks, and the precise deployment of droplets for physics and combustion experiments.

Options for Commercialization

Patents are being applied for; however, technical assistance for commercial development of this technology will be provided. Seeking collaboration through Space Act Agreement or license to the technologies.

Contact

Richard C. Oeftering
Mail Stop 86-5
NASA Lewis Research Center
Cleveland, OH 44135
Phone: (216) 433-2285
E-mail: richard.oeftering@lerc.nasa.gov

Key Words

Acoustic radiation pressure
Acoustic streaming
Drop deployment
Acoustic phased array



National Aeronautics and
Space Administration
Lewis Research Center